J. New York Entomol. Soc. 97(1):56–64, 1989

BIOLOGY OF *ANDRENA CRATAEGI* ROBERTSON (HYMENOPTERA: ANDRENIDAE), A COMMUNALLY NESTING BEE

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Abstract.—The seasonal history, nesting activity and other aspects of the biology of *Andrena* (*Plastandrena*) *crataegi* Robertson are described. This species is the second North American species of *Andrena* known to nest communally. Nest structure, orientation by females to the nest and nest site, and parasitism are discussed.

The genus *Andrena* contains 511 species in America north of Mexico (Krombein et al., 1979). The biology of most species is unknown. This paper describes the nest, life history, and other aspects of the biology of *Andrena* (*Plastandrena*) *crataegi* Robertson. *A. crataegi* is transcontinental in southern Canada and the northern United States, and its range extends to Georgia and New Mexico. LaBerge (1969) gave details of its range and floral records and redescribes the species. Rau (1922) removed a bee of this species from a shallow burrow which was evidently under construction. No further biological information is available.

Known cases of communal nesting behavior in the genus *Andrena* are rare. A British species *A. bucephala* Stephens was found by Perkins (1917) to have a large number of females per nest. Yarrow and Guichard (1941) found the same for *A. ferox* Smith, another British species. These are probably communal but detailed studies and dissections of ovaries were not made. In North America, *A. erythronii* Robertson usually has one female per nest but occasionally a nest is used simultaneously by two females (Michener and Rettenmeyer, 1956). *A. accepta* Viereck was determined to be communal by Rosen (1973). *A. crataegi* is the second North American species known to have communal nests. It was one of 20 species of *Andrena* collected on the low-bush blueberry complex by Boulanger et al. (1967), and was the second most abundant species of *Andrena* collected on this complex in Maine.

Specimens associated with this study are in the collection of the Department of Entomology at the University of Maine.

STUDY SITE AND METHODS

The communal nesting behavior of *A. crataegi* was first observed on 16 June 1966, when 11 females emerged from a single nest. A second nest was located nearby in 1967. This latter area was the principal study site and was located in a commercial low-bush blueberry field (Fig. 1) in Deblois, Washington County, Maine. Vegetation consisted principally of *Vaccinium angustifolium* Ait. and grasses, and cover was rather sparse. There was little surface organic matter, and the leached E layer was visible on the surface. Similar nesting areas are fully described by Osgood (1972).

Figs. 1, 2. 1. Nesting site of *A. crataegi* in a commercial low-bush blueberry field. 2. Female pausing at the nest entrance.

The *A. crataegi* population increased in subsequent years and field data were collected at this site in 1968, 1973 and 1987.

Commercial blueberry fields in this area are burned every other year; therefore, nests were marked with a steel wire placed 5 cm due north of the entrance. Small screen cones (Linsley et al., 1952) were used to collect adults of *A. crataegi* and its parasites as they emerged in the spring. Females of *A. crataegi* which were to be dissected were placed in alcoholic Bouin's solution for 24 hours and then transferred to 70% ethyl alcohol. Plaster of Paris was poured into nests to aid in nest excavation for life history studies. Temperature readings were taken with a mercury bulb thermometer in the shade 5 cm above ground level.

BIOLOGY

Seasonal history and nesting activity. Spring emergence data of *A. crataegi* from a large communal nest observed in 1973 shows conclusively that the species is proterandrous. The site was visited at 2–4 day intervals and on the morning of 18 May, 28 males were released from the screen cone covering the nest entrance. Most of these probably emerged on 17 May as the soil under the cone contained many burrows approximately 1.25 cm in depth. Most burrows contained one or occasionally two males which had spent the night in these shallow excavations. Six males of *Nomada cressonii* Robertson also emerged from the nest on this date. On 20 May 12 males of *A. crataegi* emerged and were released and one emerged on 23 May. The next visit was on 27 May. Ten males and 19 females of *A. crataegi* had emerged at 10:45 a.m. and were released. The screen cone was then removed from the nest entrance which was observed closely. By 1:00 p.m. twenty one additional females had emerged for a total of 40. By 1:10 p.m. emerged females had returned to the nesting area and began to enter the nest. Females continued to emerge but since newly emerging bees could not be distinguished from those entering, counts ceased.

Two specimens of *Nomada* sp. also emerged the morning of 27 May. One was released. The other was collected and determined to be a female of *N. cressonii* suggesting that this species is also proterandrous.

The first blooms of pin cherry, *Prunus pennsylvanica* L., in the immediate area were observed on 18 May. Male bees were collected resting on pin cherry blooms on this date, and a mating pair collected on pin cherry blooms on 27 May were identified as *A. crataegi*. Other matings of *A. crataegi* were observed on pin cherry and at the nesting site.

Females of *A. crataegi* often use the same nest entrance year after year. Nest construction was first observed on 30 May 1973 when a small tumulus was observed at one of the entrances to the previous year's nest. On 1 June the tumulus, which was on a level area, was 3 cm in diameter, round, with the entrance in the center. The first females laden with pollen were also observed entering the nests on this date. Six pollen laden females were collected on 20 June. These were dissected and all contained 2–6 well-developed oocytes, indicating that each was capable of ovipositing.

Observations on daily and seasonal activity of a rather large communal nest were made on several days in 1987. Females were provisioning nests on 28 May and daily activity was observed periodically thereafter. On a clear morning the first female emerged from the nest on a foraging trip as early as 7:34 a.m. and at a temperature

as low as 15.2°C. On a foggy overcast morning the first foraging trip did not begin until clearing occurred at 8:55 a.m. at a temperature of 20°C. The latest the last female was observed entering the nest was 7:05 p.m. at a temperature of 24°C. Light intensity and humidity were not measured.

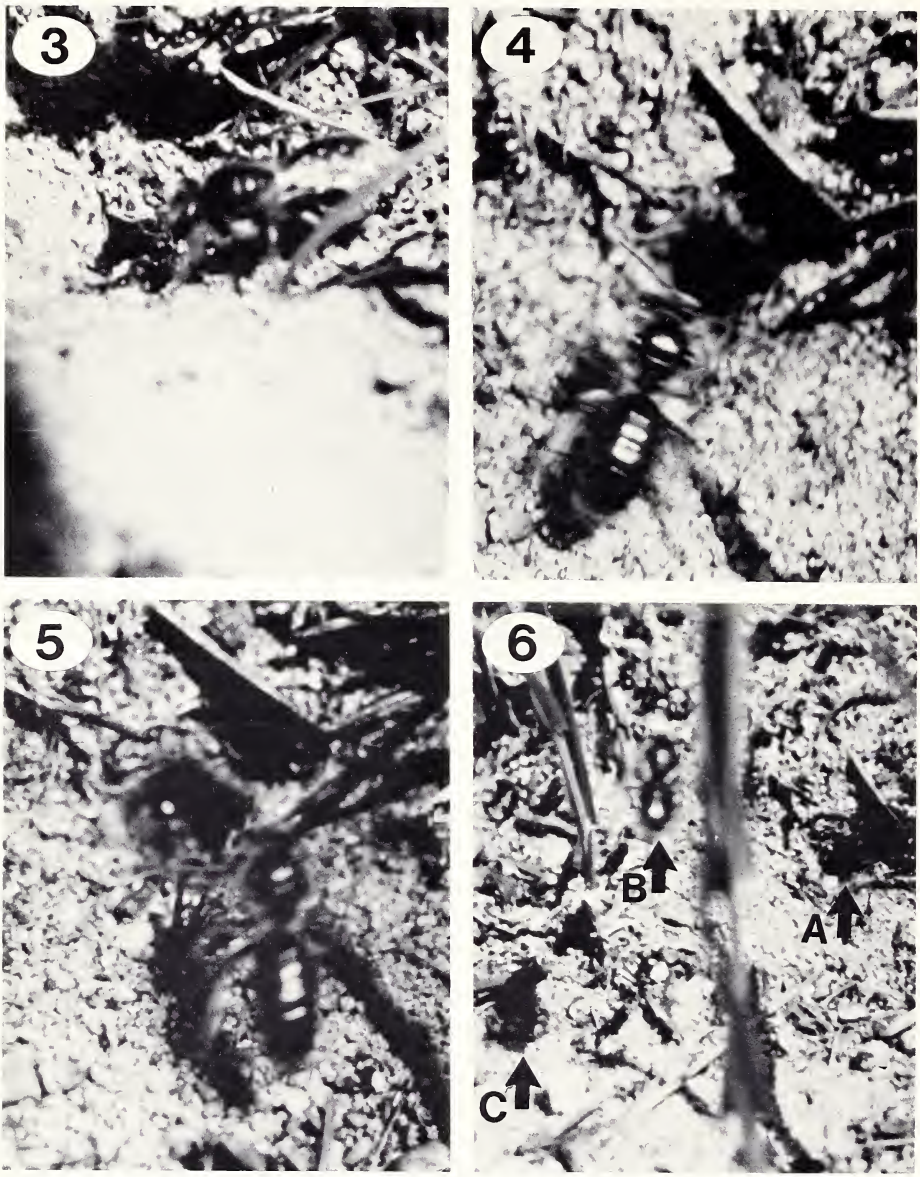
During active foraging periods females pause in the nest entrance (Fig. 2) for 5–30 seconds before taking flight. Females orient to the nest and nesting site before and during flight (Figs. 3–6). Upon emerging the female turns and faces the nest entrance (Fig. 3). She then hovers 1–2 cm above the ground near the nest entrance (Fig. 4) and slowly increases the height and distance from the nest (Figs. 5, 6). Figure 5 also shows another female in the nest entrance. They then fly at a height of 1–2 meters and 3–4 meters on all sides of the nest before leaving on a foraging trip. Early in their season of foraging activity (last of May) nearly all females orient to the nest on the first trip of the day but none orient on subsequent trips that day. Observations on 11 June showed that 13 of 29 females oriented on the first trip and for three of these the orientation time spent was relatively brief. On 16 June a second nest entrance had been constructed 5 cm from the original, and was being used. From 16 June to the end of their activity period in July only an occasional female was observed to exhibit nest orientation behavior and for some of these it was quite brief. On their return to the nest with pollen and nectar females flew directly to the nest entrance and quickly entered.

The daily tripping rates on 31 May for a single nest containing 44 females were recorded (Fig. 7). The first female appeared at the nest entrance at 8:50 a.m. and emerged at 8:55 a.m. Individual females continued to leave the nest, usually at 1–2 minute intervals, until all 44 had emerged by 11:23 a.m. The first female entered the nest with pollen at 11:45 a.m. Assuming the first out was the first to return, trip time was 2 hours 50 minutes. The first female left the nest for the second trip at 12:36 p.m. Assuming the first female completing the first foraging trip was the first female emerging for a second trip, time in the nest was 51 minutes. Eighteen females did not make a third trip as it began to darken and rain at 5:40 p.m. Under these conditions, foraging bees entered the nest at short intervals, ten entering in the final 9 minutes of activity (Fig. 7).

The recorded time elapsed on different days for a single foraging trip varied considerably from 2 hours 50 minutes to a maximum of 4 hours 43 minutes. On one occasion, when over 4 hour trips were recorded, the foliage was wet in the morning from rain the previous night, and there was a strong breeze all day. But later in their active foraging period on 2 July it was warm, foliage was dry, winds were nearly calm and trips of over 4 hours also occurred. This may have been due to the lack of pollen and nectar resources.

As expected, the number of foraging females decreased as the season progressed. From 44 on 31 May they decreased to 29 on 11 June, 20 on 16 June, 19 on 17 June, 11 on 24 June and 2 on 2 July. In other years, females have been collected in the area on *Spiraea latifolia* (Ait.) Borkh. as late as 20 July.

Nest construction and contents. Three nests were excavated on various dates to gain information on seasonal development of *A. crataegi* and its parasites and on nest architecture of *A. crataegi.* Nests varied in size but the architecture was similar. The largest nest (Fig. 8) contained four entrances and is used to illustrate nest architecture. It was excavated following completion of the seasonal development of *A.*



Figs. 3–6. Orientation of *A. crataegi* female to the nest and nesting site. 3. Female on the ground facing the nest entrance. 4–6. Females hovering at an increasing height and distance from the nest entrance. Figure 6 with arrows showing nest entrance (A), bee (B), and shadow of bee (C).

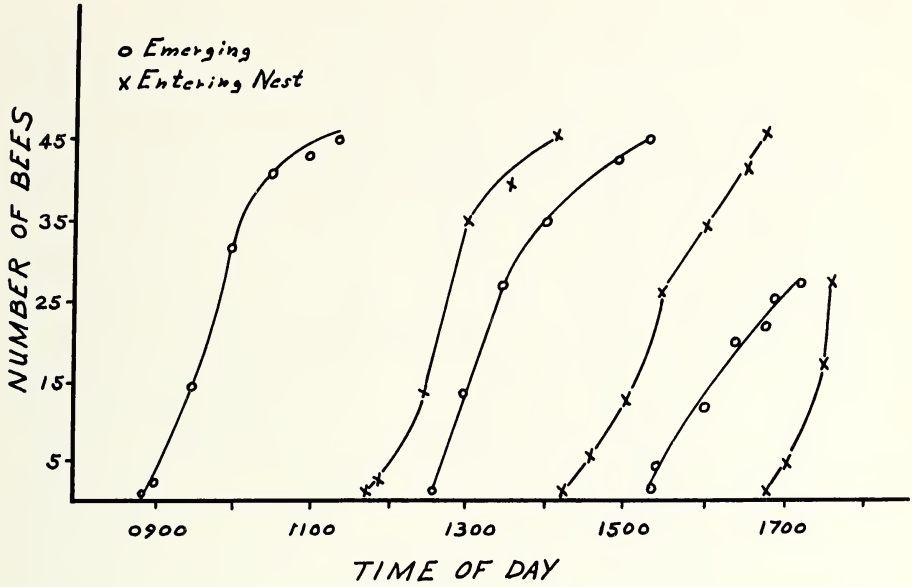


Fig. 7. Daily tripping rates for a communal nest of *A. crataegi* containing 44 females.

crataegi and is, therefore, discussed last. The two nests excavated earlier in the season were smaller, contained a single entrance, and the architecture was similar to the left portion of Figure 8.

Individual cells removed from a nest excavated on 3 July 1973 during the adult female activity period contained pollen and several life history stages. Eleven females of *A. crataegi* were still active in provisioning this nest on 3 July, and one adult of *Nomada* sp. was also observed. Twenty nine cells were recovered; 19 contained larvae of *A. crataegi,* 2 contained larvae of *Nomada* sp., and 8 cells were in various stages of being provisioned. Cells were most abundant at a depth of approximately 38 cm. In order to avoid disturbing nearby nests to be studied later, some cells were probably missed.

Cells were essentially horizontal (Fig. 8) and varied in length from 13–14 mm (7 measurements). Cells were wider near the rear, symmetrical around their long axis, and tapered gradually to the cell entrance. Maximum diameter was 7.3–7.5 mm (5 measurements), 5 mm from the rear of the cell. They were 5 mm in diameter (4 measurements) at the cell entrance. Cell closure was concave on the inside but the spiral pattern described by Rozen (1973) for *A. accepta* was not evident. Cells were lined with a shiny, waterproof substance, and the soil within 0.5 cm of the cells was more compact than the surrounding soil.

The complete pollen mass (one observed) was yellow, spherical, firm, moist and placed near the rear of the cell. The egg taken from this cell was white, slightly curved, and 1.8 mm in length and 0.4 mm in diameter. Other eggs taken from ovarioles after they had been preserved were of similar shape and color and were 2.2 mm in length and 0.5–0.6 mm in diameter. Larvae from the first to probably the last instar were

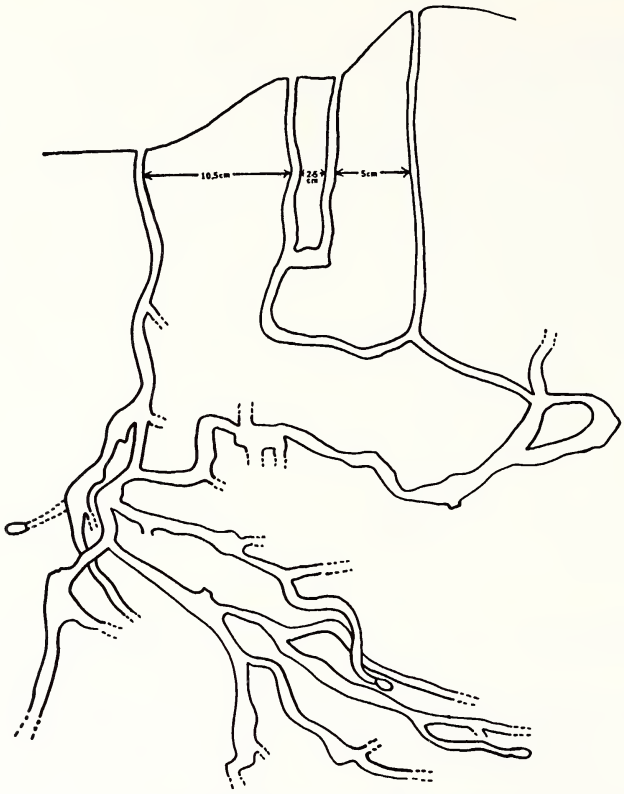


Fig. 8. Two dimensional diagram of a large communal nest of *A. crataegi* showing 4 nest entrances. Distances shown are between entrances at soil surface.

present on this date, and feces were observed as early as 13 July from larvae brought back to the laboratory.

A second nest with a single entrance was excavated in early September. The number of females originally active in provisioning this nest is not known, but the combined length of the burrow and branches was 1.08 meters and varied in diameter from 0.6–0.8 cm with some areas considerably enlarged. Of 54 cells recovered, 15 contained adult males of *A. crataegi* (3 callow), 14 contained adult females of *A. crataegi* (1 callow), 8 contained adults of *N. cressonii* (4 male and 4 female) and 17 contained larvae of an undetermined species of bombyliid. Adults of *A. crataegi* and *N. cressonii* remain in the cells and emerge the following spring.

The largest nest was excavated on 20 September 1973, and the number of provisioning females could not be determined. It contained four entrances (Fig. 8) which were relatively close together. The main burrow and its branches were open.

This nest had been used for more than one year, and the nonuniformity of the burrow diameters was striking. Burrows varied from 0.7–1.0 cm in diameter in the upper and lower extremities of the burrows with several enlarged areas ranging from

1.8–2.4 cm in diameter at the confluence of burrows. The purpose of these enlarged areas is not known but may allow for easier passage of entering and exiting bees in these nests containing a large number of active individuals. The interconnected burrows descended and began to ramify from one of these enlarged areas at a depth of about 30 cm. The burrow extended to a depth of 60 cm and contained 2.44 meters of open burrow. From the extensiveness and pattern of the burrow, it seems most likely that the Plaster of Paris did not reach all of the open burrows.

No attempt was made to recover all cells belonging to this nest. Lateral connectives leading from the main burrow were 5–6.4 cm in length and filled with loose soil. It was impossible in most instances to connect cells with the proper branch of a burrow. Burrows of other nests of *A. crataegi* were nearby, further complicating the situation. Cells were found at depths from 33–53 cm with the largest number being found at approximately 38 cm. Of the cells recovered, 16 contained adults of *A. crataegi* (11 males and 5 females), two contained adults of *N. cressonii* (1 male and 1 female) and one contained a bombyliid larva.

Adults may emerge in the spring from the same nest entrance used during the previous season, and as previously mentioned, females often use the same nest entrances year after year. Often they emerge 8–10 cm from the original entrance. Some establish new nests in the immediate vicinity from whence they emerge, and others may nest elsewhere.

The population of *A. crataegi* was observed to increase in the study area. When the nesting area was located in 1967 only 1 nest entrance was present. There were 7 in 1972 and 11 in 1973 all within a radius of approximately 2 meters. Three were determined to be occupied by lone females in 1973.

Parasitism. Since all cells were probably not recovered from excavated nests, quantitative data on parasitism rates could not be determined, and, in any event, data on 1–2 nests in any one year probably are not significant. The incidence of *N. cressonii* and an undetermined species of bombyliid have been noted. No antagonism was shown by females of *A. crataegi* toward females of *N. cressonii* as they passed in the nest entrance. The number of parasites varies greatly in different years (Perkins 1917) and judged by the adult activity of *N. cressonii* that was certainly true in this study. In 1973 several adults of *N. cressonii* were over the nest site and periodically entered the nests during most of the activity period of *A. crataegi,* but during 54 hours of observation on nine different days in 1987 not one was seen.

Adults of *Sphecodes* sp. and an unidentified anthomyiid also occasionally entered the nests and remained for long periods of time, but none were found in the cells. A crab spider, *Misumena vatia* (Clerck), was collected from *Rosa virginiana* Mill. feeding on a female of *A. crataegi.*

ACKNOWLEDGMENTS

I thank Wallace E. LaBerge, Illinois Natural History Survey, for verification of the identification of *A. crataegi,* G. I. Stage, U.S.D.A., Systematics Entomology Laboratory, for verification of the identification of its parasite *N. cressonii,* Daniel T. Jennings, F.S. U.S.D.A., for identification of the spider, Robert V. Rourke, University of Maine, for soil information, John B. Dimond, University of Maine, and Wallace E. LaBerge for their helpful comments on the manuscript.

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Received June 17, 1988; accepted July 26, 1988.